



INDIAN HEAD



GENERAL DYNAMICS
Ordnance and Tactical Systems

Selection and Final (Type) Qualification of PBXW-128 for the EFSS HE Round

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Heather Gokee
Energetics Technology Department (E3)
Indian Head Division, Naval Surface Warfare Center
101 Strauss Avenue, Indian Head, MD 20640-5035
(301) 744-4208 heather.gokee@navy.mil





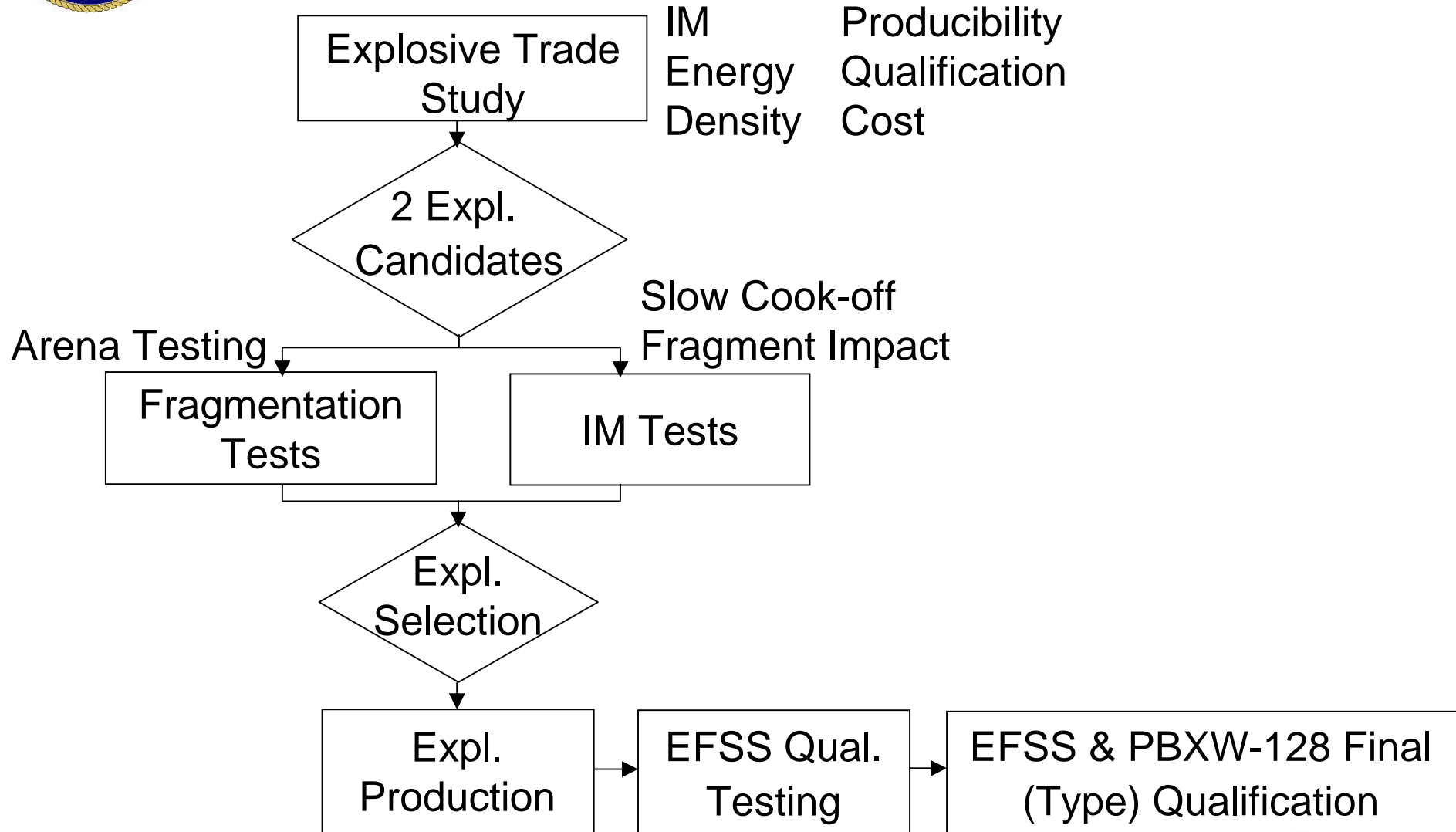
EFSS System Description

- Expeditionary Fire Support System is a U.S. Marine weapon system for all weather, ground based, close supporting, accurate, immediate response, lethal indirect fire
- General Dynamics Ordnance and Tactical Systems (GD-OTS) is the prime contractor
- System is based on the 120 mm rifled-towed mortar developed by TDA Armaments, fielded in 24 countries.
- Components
 - EFSS 120mm rifled launcher
 - EFSS prime mover/ammunition supply vehicle
 - EFSS ammunition trailer
 - 120mm rifled ammunition (HE, Illumination, Obscuration/ Incendiary, Practice)





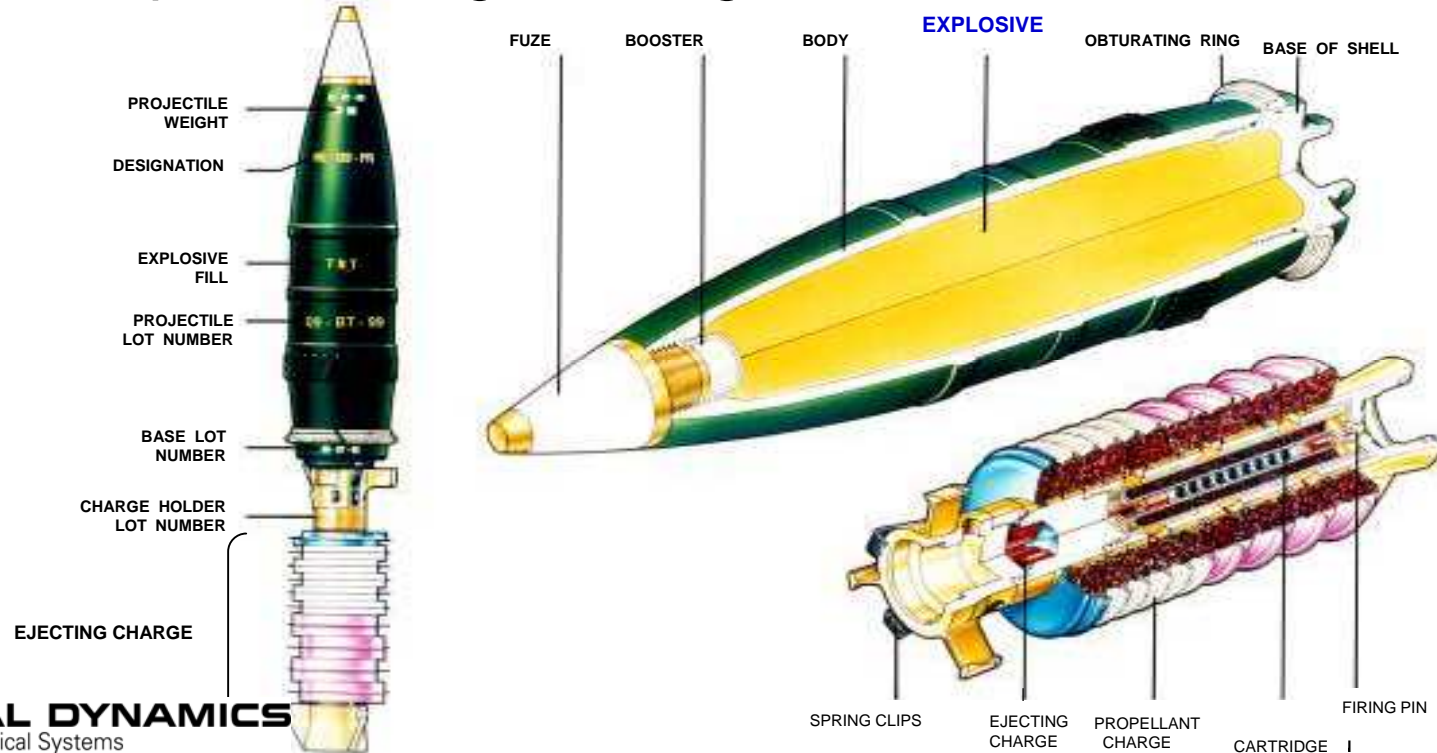
EFSS High Explosive Round Qualification





EFSS High Explosive Round

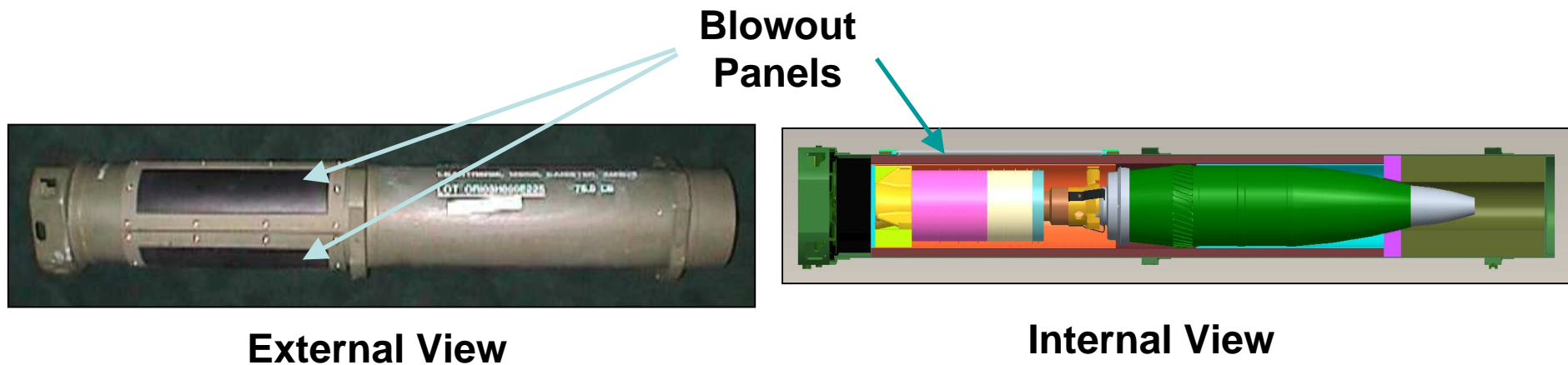
- The HE warhead body is ductile cast iron, designed and manufactured by TDA.
 - USMC round uses PBXW-128 IM fill, TDA round filled with TNT
 - Explosive weight = 4 kg





EFSS HE Round IM Features

- Key IM features in round & packaging
 - IM explosive fill, PBXW-128
 - Navy Qualified fuze, M767 A1, booster is PBXN-5
 - Fuze liner releases in cook-off environments
 - Shipping container has blowout panels, reduce confinement





EFSS High Explosive Selection Study

- Candidate explosives were identified and ranked in late 2004
- Pressed, melt-cast and cast explosives; RDX, HMX and DNAN (2,4-dinitroanisole) based explosives were considered
 - Effectiveness, IM survivability, Safety, Reliability, and Programmatic Issues
- Caveats
 - Material Navy Qualified or within 6 months of being qualified
 - Only changes to the TDA HE warhead explosive fill and the fuze.
 - Fill weight comparable to TNT



HE Qualification Data for Top Candidates

Explosive	Composition	Density (g/cc)	NOL LSGT (cards)	IM	Det Vel (mm/μsec)
PBXN-109	RDX /AI/HTPB	1.65	190	Burn ¹	7.6
PBXW-128	HMX/HTPB	1.48	124	Burn ²	7.9
PBXW-114	HMX/AI/HTPB	1.71	156	Burn ^{2*}	8.15
PBXN-110	HMX/HTPB	1.75	178		8.33
PBXIH-137	RDX/binder	1.5			7.78
TNT	TNT	1.61	135		6.9
Comp B	RDX/TNT/Wax	1.72	201		8

¹BLU-110/111

²NFTUs

*BI test only



HE Candidates Selected For Testing

- PBXN-109 (64% RDX, 20% AI)
 - + Performance in appropriate range
 - + Final Type Qualified as Navy's primary bomb fill
 - + Large production base
 - + Density close to TNT
 - Potential for shortfall in IM performance
- PBXW-128 (77% HMX)
 - + Performance in appropriate range
 - + Potential for improved IM performance
 - Unproven production/very limited production base
 - Lower density
 - Unproven reliability/safety in deployed systems



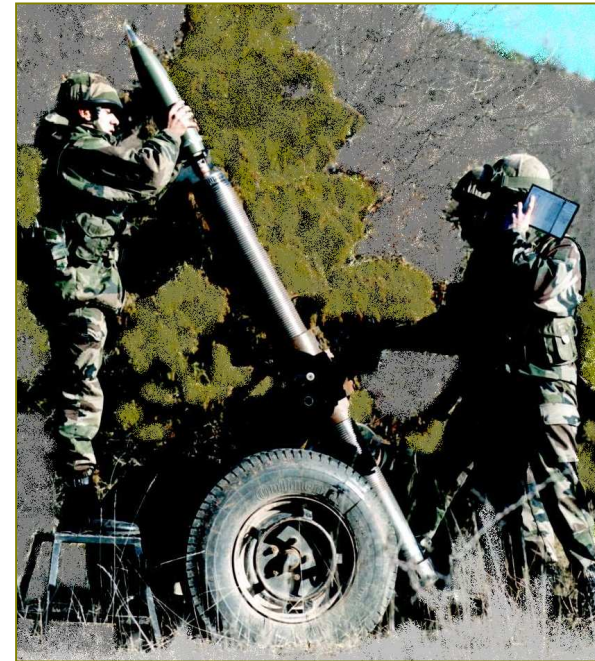
EFSS HE Down-selection Testing

- Testing focused in high risk areas for meeting program requirements
 - Lethality
 - Insensitive munitions
 - Fragment impact
 - PBXN-109 borderline, configuration dependent
 - Slow cook-off
 - Potential for hardware to drive reaction for either fill
- Testing limited to top two candidates



EFSS HE Down-select Lethality Test

- Fragmentation Tests conducted by GD-OTS, Rockhill Testing Facility, in Niceville, FL.
- Lethality for PBXN-109 and PBXW-128 fills is comparable to existing TNT fill in HE round
 - Lethal areas
 - Fragment numbers
 - Fragment velocities





EFSS HE Down-select IM Tests

- National Technical Systems (NTS) in Camden, AR performed IM testing

	FI	SCO
PBXW-128	Burn	Burn
PBXN-109	Deflagration	Burn

- Fragment impact conducted on all-up-round in container with live warhead, live propulsion, inert fuze
 - Aim point = bulk of explosive
- Slow cook-off conducted in container with a live warhead, inert propulsion, inert fuze
 - Double-base propellant would initiate first, potentially obscuring any warhead differences



EFSS HE Down-select Fragment Impact Warhead and Propelling Charge in Container

- PBXW-128 Burn



- PBXN-109 Deflagration*



GENERAL DYNAMICS *One of the PBXN-109 reactions may be considered a burn
Ordnance and Tactical Systems



EFSS HE Down-select Slow Cook-off Tests Warhead in Container

- PBXW-128 Burn



- PBXN-109 Burn





PBXW-128 Qualification Data

- PBXW-128 selected for EFSS HE round explosive fill

Parameter	Value	Reference
Composition	77% HMX /HTPB	
Advantages	Very insensitive: explosively deformable, high setback survivability	
Performance	Moderate	
Typical Density	1.48 g/cc	
TMD	1.51 g/cc	
No. 8 Cap	Detonation	
ERL Impact	38.6 cm	RDX: 7.4 cm
ABL Friction	>980 lb _f @ 8 ft/s	
ESD	4.2 joules (No Fire)	
NOL LSGT	124 cards/48.8 Kbar	Comp B: 201 cards
Det. Velocity	7.973 mm/s @ 1.48 g/cc	
Critical Diameter	<0.25 inches	
Coef. of Thermal Expan.	180 X 10 ⁻⁶ m/m-deg C [#] to 332 X 10 ⁻⁶ m/m-deg C*	

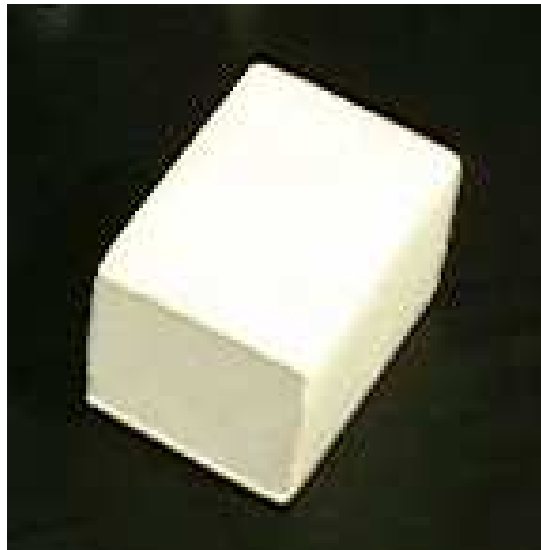
#full scale in EFSS HE round

*lab scale



PBXW-128 Production

- Explosive production has been successfully transitioned to from IHDIV, NAVSURFWARCEN Yorktown Detachment to Ensign-Bickford Aerospace and Defense Co., Graham, KY
- Three sites have produced PBXW-128





EFSS HE Round Final (Type) Qualification Test Plans

Testing	Specification/Requirement
Hazard Assessment and Classification Testing/Basic Safety and IM Testing -Combined 28-Day Temperature & Humidity and Thermal Stability -Combined Fast Cook-off/External Fire -Combined Sympathetic Reaction/Stack Test -Excluding Spall Impact.	NAVSEAINST 8020.8C /MIL-STD-2105C
Environmental/Durability Safety Tests	MIL-STD-810F
Unpackaged Drop	MIL-STD-331
Environmental Safety Tests	NAVSEAINST 8020.19 /MIL-STD-464A



EFSS HE Round Final (Type) Qualification Test Plans

Testing	Specification/Requirement
Shipboard Shock	MIL-S-901D
Fuze Safety	MIL-STD-1316E /MIL-STD-331B
Fuze Arming Distance and Double Loading	MIL-STD-331C
Gun testing at proof pressure Acoustic assessment during firings Products of combustion toxicity analysis	Review by Naval Environmental Health Center (NEHC)
Hot gun testing	ITOP 4-2-504(3)
Performance Oriented Packaging (POP)	Title 49 CFR, Sections 178.603, 178.606 and 178,608
UN Replenishment/VERT Replenishment	MIL-STD-648C



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Acknowledgements

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